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Effects of Dietary Metabolizable Energy and Crude Protein Concentrations on Growth Performance and Carcass Characteristics of French Guinea Broilers

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ABSTRACT This study was undertaken to assess dietary CP and ME concentrations for optimum growth performance and carcass characteristics of French guinea broilers. In a 3 × 3 factorial arrangement, 396 1-d-old French guinea keets were randomly assigned to experimental diets with 3,050, 3,100, and 3,150 kcal of ME/kg of diet; each contained 21, 23, and 25% CP, respectively, from 0 to 4 wk of age (WOA). From 5 to 8 WOA, experimental diets had 3,100, 3,150, and 3,200 kcal of ME/kg of diet, and each contained 19, 21, and 23% CP, respectively. Each dietary treatment was replicated 3 times, and feed and water were provided ad libitum. Body weight and feed consumption were measured weekly, whereas carcass characteristics were evaluated at 8 WOA. For the most part, birds on 3,100 and 3,150 kcal of ME/kg of diet at 0 to 4 WOA exhibited greater ($P < 0.05$) BW gain, greater carcass and breast weights ($P < 0.05$), and lower ($P < 0.05$) feed consumption and feed conversion ratios (FCR) than those on a diet with 3,050 kcal of ME/kg. Mean feed consumption of birds fed 25% CP diets was higher ($P < 0.05$) than those on other dietary CP concentrations. Mean BW gain, FCR, and carcass and breast weights of birds fed 25 and 23% CP diets from 0 to 4 WOA were not different ($P > 0.05$), but they were better ($P < 0.05$) than those of birds on 21% CP diets. Positive correlations ($P < 0.01$) were noted between live weight and weight of carcass, breast, thigh, drumstick, and wing of guinea broilers. Thus, diets with 3,100 kcal of ME/kg and 23% CP or with 3,150 kcal of ME/kg and 21% CP at 0 to 4 WOA and 5 to 8 WOA, respectively, were used more efficiently by French guinea broilers.

(*Key words*: carcass trait, crude protein, guinea fowl, metabolizable energy)

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INTRODUCTION

Guinea fowl production for meat is a potentially profitable enterprise in various parts of the world including the United States. A recent survey (Nahashon et al., 2004) indicated that interest in guinea fowl as a specialty meat bird in the United States appears to be increasing. Consumer evaluation (Hughes, 1980) showed that a majority of participants in a study indicated that guinea meat was at least equal to chicken and that they would buy it occasionally if available at a competitive price. Guinea fowl production has already proven to be a profitable enterprise in Canada and also in European markets such as France and Italy (Embury, 1998). Guinea fowl, an alternative meat to chicken, is gradually finding its share of the US market for poultry and poultry products because of the changing demographics of the US population.

Guineas, especially the French variety, exhibit rapid growth, have good feed conversion, reach market size at an early age, and have excellent quality meat (Vo et al., 1986). Lacking, however, is sufficient information relating to nutrient requirements of these birds. There is general consensus that the determination of nutrient requirements of different types of poultry is necessary to efficiently use their genetic potential for specific production goals (Pym, 1990). Although information on nutrient requirements of the guinea fowl is minimal, current estimates of energy and protein requirements for the French guinea fowl are based on information derived from studies conducted using the pearl gray variety. The pearl gray is a much smaller bird that is raised primarily for egg production. Although quite inconclusive, several studies have evaluated the metabolizable energy and CP requirements of the pearl gray guinea fowl (Hughes and Jones, 1980; Sales and Du Preez, 1997; Vo et al., 1987).

Information on CP and ME requirements for growth and carcass characteristics of the French variety of guinea

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Abbreviation Key: FCR = feed conversion ratio; WOA = weeks of age.

TABLE 1. Composition of experimental diets fed from 0 to 4 wk of age (%)

ME, kcal/kg	3,050	3,100	3,150	3,050	3,100	3,150	3,050	3,100	3,150
CP, %	21	21	21	23	23	23	25	25	25
Ingredient, %									
Corn, yellow #2 (8% CP)	59.63	58.35	57.00	53.80	52.32	51.02	47.51	46.20	44.81
Soybean meal (48% CP)	30.42	30.60	30.90	35.32	35.70	35.90	40.60	40.81	41.10
Alfalfa meal (17% CP)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Meat and bone meal (50% CP)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Poultry blended fat	2.90	4.00	5.05	3.80	4.90	6.00	4.80	5.90	7.00
Dicalcium phosphate (18% P, 22% Ca)	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86
Limestone flour (38.8 % Ca)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin-mineral premix[1]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-methionine (98%)[2]	0.12	0.12	0.12	0.15	0.15	0.15	0.16	0.16	0.16
Calculated level									
ME (kcal/kg of diet)	3,050	3,100	3,150	3,050	3,100	3,150	3,050	3,100	3,150
Crude protein, %	21	21	21	23	23	23	25	25	25
Calcium, %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Phosphorus, total	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Available Phosphorus, %	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Methionine, %	0.45	0.45	0.45	0.51	0.51	0.51	0.54	0.54	0.54
Methionine + cystine, %	0.80	0.80	0.80	0.88	0.88	0.88	0.94	0.94	0.94
Lysine, %	1.14	1.14	1.14	1.27	1.27	1.27	1.41	1.41	1.41

[1]Provided per kilogram of diet: retinyl acetate, 3,500 IU; cholecalciferol, 1,000 ICU; DL-α-tocopheryl acetate, 4.5 IU; menadione sodium bisulfite complex, 2.8 mg; vitamin B_{12}, 5.0 mg; riboflavin, 2.5 mg; pantothenic acid, 4.0 mg; niacin, 15.0 mg; choline, 172 mg; folic acid, 230 mg; ethoxyquin, 56.7 mg; manganese, 65 mg; iodine, 1 mg; iron, 54.8 mg; copper, 6 mg; zinc, 55 mg; selenium, 0.3 mg.

[2]Eli Lilly, Indianapolis, IN.

fowl is lacking. In the present study the effect of various concentrations of dietary ME and CP on growth performance and carcass characteristics of the French guinea keet broilers were evaluated. The National Research Council (1994) suggested that in addition to reproductive performance, growth rate, considered as a function of average weight at specific ages, should be included among factors used to assess and define nutrient use and nutritional status of poultry. Pesti (1982) and Pesti and Fletcher (1983) also reported differences in weight gain and feed consumption with changes in dietary energy or protein content.

MATERIALS AND METHODS

Birds and Dietary Treatments

Straight-run 1-d-old guinea keets (n = 396) of the French variety were obtained from Ideal Poultry Breeding Farms.[2] These birds were randomly assigned to 9 dietary treatments in a 3 × 3 factorial arrangement. The dietary treatments fed at hatch to 4 wk of age (WOA) contained 3,050, 3,100, and 3,150 kcal of ME/kg of diet each in combination with 21, 23, and 25% CP (Table 1). These diets were adjusted to contain 3,100, 3,150, and 3,200 kcal of ME/kg of diet each in combination with 19, 21, and 23% CP, respectively, and were fed from 5 to 8 WOA (Table 2). Each dietary treatment was replicated 4 times. The diets were fed in marsh form and were provided ad libitum. Water was also provided freely throughout the experimentation period.

[2]Cameron, TX.

[3]Petersime (www.petersime.com).

Management of Experimental Birds

At 1 d of age, experimental birds were weighed individually and randomly assigned to electrically heated, temperature-controlled Petersime[3] battery brooders equipped with raised-wire floors for the first 4 WOA. The battery cages measured 99 × 66 × 25 cm, and each housed 11 birds. At 1 d of age, the brooder temperature was maintained at 32.2°C for the first week and was reduced gradually by 2.8°C every week until 23.9°C was reached, after which no artificial heating was provided. At 5 WOA the guinea keet broilers were transferred into growing batteries that were not supplied with supplemental heating. However constant room temperature was maintained at 21°C. The growing batteries measured 162 × 68 × 33 cm, and each housed 11 birds from 5 to 8 WOA. The birds received 23 h constant lighting throughout. Ventilation within the battery holding room was maintained by thermostatically controlled exhaust fans. Body weight and feed consumption were measured weekly to 8 WOA. Mortality was recorded as it occurred.

Processing Procedures

At 8 WOA, 6 birds from each replicate (a total of 24 birds within each dietary treatment group) were randomly selected for evaluation of carcass traits. Feed and water were withdrawn 12 h prior to slaughter. The birds were then manually caught and crated in plastic coops such that each coop contained 8 birds. These birds were transported less than 0.1 km to the processing facility. While hanging by their feet, all 24 birds from each dietary treatment group were electrically stunned by passing their heads through 1% NaCl solution charged with electrical current (14 V, 60 Hz) for 18 s. Birds were killed by

TABLE 2. Composition of experimental diets fed from 5 to 8 wk of age (%)

ME, kcal/kg	3,100	3,150	3,200	3,100	3,150	3,200	3,100	3,150	3,200
CP, %	19	19	19	21	21	21	23	23	23
Ingredient									
Corn, yellow #2 (8% CP)	64.11	63.12	61.65	58.33	56.98	55.70	52.19	51.00	49.70
Soybean meal (48% CP)	25.64	25.64	26.00	30.60	30.90	31.10	35.80	35.90	36.10
Alfalfa meal (17% CP)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Meat and bone meal (50% CP)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Poultry blended fat	3.20	4.19	5.30	4.00	5.05	6.13	4.90	6.00	7.10
Dicalcium phosphate (18% P, 22% Ca)	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
Limestone flour (38.8 % Ca)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin-mineral premix[1]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-methionine (98%)[2]	0.10	0.10	0.10	0.12	0.12	0.12	0.15	0.15	0.15
Calculated level									
ME, kcal/kg of diet	3,100	3,150	3,200	3,100	3,150	3,200	3,100	3,150	3,200
CP, %	19	19	19	21	21	21	23	23	23
Calcium, %	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Phosphorus, total	0.72	0.72	0.72	0.73	0.72	0.72	0.73	0.73	0.73
Available Phosphorus, %	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Methionine, %	0.42	0.42	0.42	0.45	0.45	0.45	0.51	0.51	0.51
Methionine + cystine, %	0.74	0.74	0.74	0.80	0.80	0.80	0.88	0.88	0.88
Lysine, %	1.01	1.01	1.01	1.14	1.14	1.14	1.27	1.27	1.27

[1]Provided per kilogram of diet: retinyl acetate, 3,500 IU; cholecalciferol, 1,000 ICU; DL-α-tocopheryl acetate, 4.5 IU; menadione sodium bisulfite complex, 2.8 mg; vitamin B_{12}, 5.0 mg; riboflavin, 2.5 mg; pantothenic acid, 4.0 mg; niacin, 15.0 mg; choline, 172 mg; folic acid, 230 mg; ethoxyquin, 56.7 mg; manganese, 65 mg; iodine, 1 mg; iron, 54.8 mg; copper, 6 mg; zinc, 55 mg; selenium, 0.3 mg.

[2]Eli Lilly, Indianapolis, IN.

hand using a conventional unilateral neck cut to sever the carotid artery and jugular vein and bled for 180 s. They were then scalded for 120 s at 63°C in an air-agitated commercial scalder (model SS300CF)[4] and picked for 30 s in a commercial inline picker (model CPF-60).[4] After the head, shanks and feet, and feathers were removed, the carcass was eviscerated manually by cutting around the vent to remove all of the viscera including the kidneys. Abdominal fat, which consisted of fat surrounding the gizzard, proventriculus, and in the abdominal body cavity, was removed and weighed immediately. The weight of heart, liver, and gizzard were also measured. Eviscerated carcass (with neck and the ends of wings) without giblets was weighed to determine hot dressed yield. Each carcass was cut into its component parts: breast, thigh, drumstick, wings, and neck. All weights were recorded to the nearest 0.1 g.

Statistical Analyses

Data were analyzed by the ANOVA option of GLM of the SAS/STAT software (SAS Institute, 1999) as a 3 × 3 factorial arrangement of dietary treatments with dietary ME and CP as main effects. Carcass and organ weights were transformed to common logarithms prior to analyses. Percentage carcass data were transformed into arc sine coefficients prior to analysis and were back-transformed for tabulation. The statistical model used was $Y_{ijkl} = \mu + M_i + P_j + (MP)_{ij} + R_{ijk} + \varepsilon_{ijkl}$, where Y_{ijkl} = response variables from each individual bird, μ = the overall mean, M_i = the effect of dietary metabolizable energy, P_j = the effect of dietary CP, $(MP)_{ij}$ = the effect due to interactions between dietary metabolizable energy and CP, R_{ijk} = the interexperimental unit (replications) error term, and ε_{ijkl} = the intraexperimental unit error term. Two-way interactions between CP and ME were not significant ($P > 0.05$); thus, data were analyzed for main effects. Least significant difference comparisons were made among treatment means for main effects when there was a significant F-value. Differences in mortality among dietary treatments were analyzed using the χ^2 method. Significance implies $P < 0.05$ unless stated otherwise.

[4]Cantrell Machine Co., Inc., Gainesville, GA.

RESULTS AND DISCUSSION

Throughout the results and discussion we referenced varying levels of dietary ME and CP provided to French guinea broilers from hatch to 4 WOA. The average daily feed consumptions of French guinea broilers on varying dietary ME and CP levels are presented in Table 3. A significant decrease in feed consumption that was associated with increase in ME was observed at 3 to 8 WOA. At 6 WOA, birds on 3,050, 3,100, and 3,150 kcal of ME/kg consumed 518, 507, and 492 g of feed, respectively. This observation was in agreement with reports by Golian and Maurice (1992) and Leeson et al. (1993) in that birds consume feed to primarily meet energy requirements. Birds on high-energy diets, often due to relatively high fat content, have on average lower feed consumption due to reduced rate of passage of digesta through the gastrointestinal tract (Sturkie, 1976). Although feed consumption was ($P < 0.05$) decreased by increasing dietary ME from 3,050 to 3,100 kcal of ME/kg of diet, differences in feed consumptions of birds fed 3,100 and 3,150 ME kcal/kg

TABLE 3. Feed consumption of French guinea broilers fed diets with varying concentrations of ME and CP

		Age (wk)								
0–4 WOA[1]	5–8 WOA	1	2	3	4	5	6	7	8	TFC[2]
		(g/bird)								
ME kcal/kg of diet										
3,050	3,100	142	233	361[a]	393[a]	505[a]	518[a]	484[a]	518[a]	3,154[a]
3,100	3,150	142	236	323[b]	391[ab]	490[b]	507[b]	468[b]	478[b]	3,035[b]
3,150	3,200	140	237	319[b]	384[b]	471[c]	492[c]	459[b]	471[b]	2,973[c]
PSEM[3]		1.0	1.5	1.7	2.6	3.8	3.3	3.4	3.8	14.6
CP, %										
21	19	139	231[b]	327[b]	372[b]	469[b]	486[b]	476[b]	492[b]	2,992[b]
23	21	136	232[b]	331[b]	379[b]	473[b]	499[b]	475[b]	477[c]	3,002[b]
25	23	139	242[a]	346[a]	389[a]	486[a]	508[a]	490[a]	507[a]	3,107[a]
PSEM		1.0	0.8	1.1	0.6	3.8	1.8	3.3	2.4	15.9
Probability										
ME		NS	NS	0.01	0.05	0.04	0.01	0.05	0.04	0.05
CP		NS	0.05	0.05	0.05	0.03	0.05	0.05	0.05	0.05
ME × CP		NS	NS	NS	NS	NS	NS	NS	NS	NS

[a,b]Gram weight means within columns of ME or CP level with no common superscript differ ($P < 0.05$).
[1]Weeks of age.
[2]Total feed consumed.
[3]Pooled standard error of mean.

diet were not significant. Analysis of published reports by Morris (1968) also suggested that the effect of dietary energy on performance of growing birds is dependent on an animal's capacity to alter feed intake to meet changing demands for calories.

Feed intake was also influenced by dietary CP levels. Except at 7 WOA when birds on 21% CP diets consumed more feed ($P < 0.05$) than those on 23% CP diets, feed consumption of guinea broilers receiving diets containing 21 or 23% CP diets were not different ($P > 0.05$). Birds on 25% CP diets consumed about 3 to 4% more feed and 3 to 6% more feed than those on diets containing 23 and 21% CP, respectively. The higher feed intake for birds on higher CP diets is consistent with the findings by Sengar (1987) but quite contrary to the report of Waldroup et al. (1990) in which low-CP diets significantly depressed appetite. Other reports (Leeson and Summers, 1989) also support this premise.

Table 4 presents mean BW gains of guinea broilers fed diets containing varying levels of ME and CP. Increased dietary ME was associated with increased BW gain of guinea broilers. With the exception of 3, 5, 6, and 7 WOA, birds on 3,100 kcal of ME/kg of diet exhibited greater ($P < 0.05$) BW gain than those on 3,050 kcal of ME/kg. However, differences in BW gain of birds fed diets containing 3,100 or 3,150 kcal of ME/kg of diet were not evident ($P > 0.05$). Although these dietary energy levels seem adequate for the French guinea broilers, 3,050 kcal of ME/kg seem suboptimal. Increasing dietary CP from 21 to 23% improved BW gain of guinea broilers at 3, 5, and 6 WOA. Except at 5 WOA, when birds on 25% CP diets were heavier ($P < 0.05$) than those on 23% CP diet, differences in BW gain of birds on 25 and 23% CP diets were not ($P > 0.05$). The increase in feed consumption at higher CP levels (Table 3) may also be associated with the higher BW gain of birds on these diets. The heavier BW may be attributed to increased nitrogen consumption also arising from increased feed consumption (Table 3). This observation is consistent with a report by Sengar (1987) in which lowering dietary CP also reduced BW gain and feed efficiency of chicks. The lower BW gain of birds on 21% CP diet as opposed to those on 23 and 25% CP diets could have been due to inadequate levels of one or more essential amino acids in the 21% CP diet. In similar studies, Schutte (1987) reported that the decrease in performance of birds fed 16% CP diet was minimal when supplements of all essential amino acids, at levels equivalent to that present in 20% CP diet, were provided. Percentage of mortality (Table 4) among dietary treatments was not significant.

Average feed conversion ratio (FCR) of guinea broilers was lower ($P < 0.05$) in birds fed diets containing 3,100 and 3,150 kcal of ME/kg of diet than those fed 3,050 kcal of ME/kg except at 1 and 6 WOA (Table 5). Throughout the study period, differences in FCR of guinea broilers on 3,100 and 3,150 kcal of ME/kg of diet were not evident ($P > 0.05$). The average difference in FCR between birds on 3,100 and those on 3,050 kcal of ME/kg of diet was as low as 5% at 5 WOA and as high as 17% at 8 WOA. While investigating the protein and energy requirement of the pearl gray guinea fowl, Sales and Du Preez (1997) reported a steady increase in energy requirement proportionate to age of birds. They reported the highest requirement for energy in these birds to be at 9 and 10 WOA in males and females, respectively. The feed conversion ratio decreased ($P < 0.05$) when dietary CP was increased from 21 to 23%. The average decrease in FCR ranged from 4% at 7 and 8 WOA to 9% at 5 WOA. However, FCR of birds on 21 or 23% CP diets were not different at 3 and 4 WOA ($P > 0.05$). Previous studies using the pearl gray guinea fowl (Sales and Du Preez, 1997), which were in agreement with this report, suggested that the highest protein re-

TABLE 4. Body weight gain and mortality of French guinea broilers fed diets with varying concentrations of ME and CP

		Age (wk)								
0–4 WOA[1]	5–8 WOA	1	2	3	4	5	6	7	8	Mortality
		(g/bird)								(%)
ME, kcal/kg of diet										
3,050	3,100	76.5^{b}	130.1^{b}	169.1^{ab}	186.5^{b}	230.5	199.9	163.0	163.5^{b}	1.30
3,100	3,150	92.2^{a}	140.5^{a}	167.2^{b}	197.5^{a}	234.0	202.2	168.6	176.3^{a}	1.00
3,150	3,200	88.2^{a}	138.9^{a}	175.4^{a}	195.6^{a}	233.9	209.1	168.4	182.7^{a}	1.00
PSEM[2]		2.2	2.3	2.6	2.3	4.4	3.3	3.4	3.8	0.25
CP, %										
21	19	85.5	131.3^{b}	170.0^{b}	190.9	208.5^{c}	192.2^{b}	163.5	174.1	1.10
23	21	88.5	137.1^{ab}	179.2^{a}	194.7	228.3^{b}	209.8^{a}	169.1	176.2	1.13
25	23	83.5	141.0^{a}	172.6^{ab}	193.9	241.6^{a}	209.2^{a}	167.3	172.2	1.12
PSEM		2.1	2.2	2.5	2.6	3.1	3.4	3.3	3.9	0.27
Probability										
ME		0.04	0.05	0.05	0.05	NS	NS	NS	0.04	0.05
CP		NS	0.05	0.05	NS	0.03	0.05	NS	NS	0.05
ME × CP		NS	NS	NS	NS	NS	NS	NS	NS	NS

[a–c]Gram weight means within columns of ME or CP level with no common superscript differ ($P < 0.05$).

[1]Weeks of age.

[2]Pooled standard error of mean.

quirement of guinea fowl occurs from 5 to 10 WOA. The improved feed efficiency of birds fed the 23% CP diets could be attributed to the heavier BW and increased nitrogen and energy consumption when compared with the 21% CP diets. Fancher and Jensen (1989) reported that lowering dietary CP without supplementing diets with essential amino acids depressed feed efficiency. For the most part, increasing the dietary CP levels further to 25% resulted in 5 to 8% increased FCR at 1, 3, 7, and 8 WOA. This may be attributed to increased feed consumption of the birds on 25% CP diets resulting from a lower energy to protein ratio. However, increasing dietary CP from 23 to 25% did not significantly change the FCR of French guinea broilers at 2, 4, 5, and 6 WOA.

Mean carcass and associated traits of French guinea broilers fed diets with varying CP and ME levels are presented in Table 6. Although eviscerated carcass weights of birds on 3,100 and 3,150 kcal of ME/kg of diet were not different ($P > 0.05$), they were both higher ($P < 0.05$) by 1 and 1.8%, respectively than those of birds on 3,050 kcal of ME/kg of diet. Breast weights of birds fed diets containing 3,100 and 3,150 kcal of ME/kg of diet were not different, but they were 3% higher ($P < 0.05$) than those of birds fed 3,050 kcal of ME/kg of diet. Also when expressed as percentage of live BW (Table 7), mean carcass and breast weights of guinea broilers fed 3,100 or 3,150 kcal of ME/kg of diet were heavier ($P < 0.05$) than those of broilers on 3,050 kcal of ME/kg of diet. Differ-

TABLE 5. Feed conversion ratio of French guinea broilers fed diets with varying concentrations of ME and CP

		Age (wk)								
0–4 WOA[1]	5–8 WOA	1	2	3	4	5	6	7	8	AFCR[2]
		(g of feed/g of weight gain)								
ME, kcal/kg ofd diet										
3,050	3,100	1.85	1.81^{a}	2.11^{a}	2.09^{a}	2.19^{a}	2.58^{a}	2.96^{a}	3.15^{a}	2.34^{a}
3,100	3,150	1.54	1.70^{b}	1.92^{b}	1.98^{b}	2.09^{b}	2.50^{ab}	2.76^{b}	2.70^{b}	2.15^{b}
3,150	3,200	1.59	1.70^{b}	1.82^{b}	1.95^{b}	2.03^{b}	2.36^{b}	2.73^{b}	2.60^{b}	2.10^{b}
PSEM[3]		0.03	0.03	0.04	0.02	0.04	0.05	0.02	0.05	0.03
CP, %										
21	19	1.64^{a}	1.77^{a}	1.92^{ab}	1.95	2.24^{a}	2.53^{a}	2.91^{a}	2.84^{b}	2.23^{a}
23	21	1.54^{b}	1.67^{b}	1.86^{b}	1.93	2.06^{b}	2.37^{b}	2.80^{b}	2.72^{c}	2.12^{b}
25	23	1.66^{a}	1.72^{ab}	1.98^{a}	2.01	2.02^{b}	2.43^{ab}	2.94^{a}	2.94^{a}	2.21^{ab}
PSEM		0.02	0.03	0.03	0.04	0.03	0.04	0.03	0.03	0.03
Probability										
ME		NS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
CP		0.05	0.05	0.05	NS	0.05	0.05	0.05	0.05	0.05
ME × CP		NS	NS	NS	NS	NS	NS	NS	NS	NS

[a–c]Gram weight means within columns of ME and CP levels with no common superscript differ ($P < 0.05$).

[1]Weeks of age.

[2]Average feed conversion ratio.

[3]Pooled standard error of mean.

TABLE 6. Mean yield of carcass and major component parts of French guinea broilers fed diets with varying concentrations of CP and ME

0–4 WOA[1]	5–8 WOA	Carcass[2]	Breast	Thigh	Drumstick	Wings	Neck	Abdominal Fat	Heart	Liver	Gizzard
		weight (g)									
ME, kcal/kg											
3,050	3,100	913.80[b]	244.20[b]	171.10	126.60	142.00	56.20	9.30[b]	6.40	17.80	20.40
3,100	3,150	923.60[a]	251.50[a]	170.40	126.70	142.20	58.40	9.70[ab]	6.30	17.90	21.20
3,150	3,200	930.00[a]	251.70[a]	171.80	128.30	145.30	57.40	10.60[a]	6.40	17.40	21.40
PSEM[3]		3.10	2.00	2.50	1.50	1.60	1.80	0.40	0.20	0.40	0.60
CP, %											
21	19	912.70[b]	245.50[b]	169.90	127.50	142.40	57.70	9.40[b]	6.50	18.00	21.50
23	21	926.10[a]	248.10[ab]	171.00	127.80	144.50	56.90	9.70[b]	6.50	17.70	20.10
25	23	927.70[a]	253.90[a]	172.40	126.40	142.70	57.30	10.70[a]	6.10	17.50	21.30
PSEM		3.40	2.20	2.30	1.50	1.60	1.00	0.40	0.20	0.30	0.70
Probability											
ME		0.04	0.05	NS	NS	NS	NS	0.05	NS	NS	NS
CP		0.05	0.05	NS	NS	NS	NS	0.05	NS	NS	NS
ME × CP		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a,b]Gram weight means within columns with no common superscript differ ($P < 0.05$).
[1]Weeks of age.
[2]Eviscerated.
[3]Pooled standard error of mean.

ences in percentages of carcass and breast weights between birds on 3,100 and 3,150 kcal of ME/kg of diet did not differ ($P > 0.05$). As expected, carcass and breast weights showed the same basic relationship discussed for live weight gain with respect to dietary energy levels. This notion was further supported by the positive and significant correlations between live weight and carcass and breast weights (0.76 and 0.43, respectively) of the guinea broilers (Table 8).

Increasing dietary ME from 3,050 to 3,150 kcal/kg diet was associated with increased ($P < 0.05$) abdominal fat deposition. Average weights of abdominal fat in birds fed diets containing 3,100 and 3,150 kcal of ME/kg of diet were 4.3 and 14% higher than those of birds on 3,050 kcal of ME/kg of diet, respectively. Because birds on diets containing 3,100 and 3,150 kcal of ME/kg exhibited more rapid growth than those on 3,050 kcal of ME/kg of diet, this observation is consistent with the report of Marks (1990) that faster growing birds deposit more fat than their slower growing counterparts. Excess energy from diets with higher ME values will normally be stored as fat. Differences in weights of thigh, drumstick, wings, neck, heart, liver, and gizzard were not significant among dietary ME levels.

Mean eviscerated carcass and breast weights of guinea broilers fed a diet with 23 or 25% CP were not different. However, mean carcass weights of birds on 25 and 23% CP diets and breast weights of birds on 25% CP diets were higher ($P < 0.05$) than those of birds on 21% CP diets. When expressed as percentage of live BW (Table 7), carcass and breast weights of guinea broilers fed the 25% CP diets were higher ($P < 0.05$) than those of birds

TABLE 7. Mean yield of major component parts expressed as a percentage of live BW after feed deprivation of French guinea broilers fed diets with varying concentrations of CP and ME

0–4 WOA[1]	5–8 WOA	Carcass[2]	Breast	Thigh	Drumstick	Wings	Neck	Abdominal Fat	Heart	Liver	Gizzard
		(%)									
ME, kcal/kg											
3,050	3,100	70.22[b]	19.18[b]	13.32	9.87	11.06	4.04	0.74	0.50	1.39	1.58
3,100	3,150	72.02[a]	19.49[ab]	13.32	9.96	11.12	4.56	0.79	0.49	1.39	1.65
3,150	3,200	72.72[a]	19.76[a]	13.44	9.99	11.39	4.48	0.80	0.50	1.36	1.68
PSEM[3]		0.51	0.13	0.18	0.19	0.13	0.08	0.03	0.02	0.05	0.08
CP, %											
21	19	71.12[b]	19.13[b]	13.36	9.91	11.08	4.43	0.74	0.50	1.38	1.57
23	21	71.91[ab]	19.56[ab]	13.27	9.87	11.10	4.53	0.80	0.49	1.40	1.66
25	23	72.96[a]	19.76[a]	13.45	10.03	11.38	4.47	0.80	0.50	1.36	1.67
PSEM		0.60	0.19	0.16	0.15	0.18	0.09	0.02	0.02	0.06	0.05
Probability											
ME		0.05	0.05	NS	NS	NS	NS	NS	NS	NS	NS
CP		0.05	0.05	NS	NS	NS	NS	NS	NS	NS	NS
ME × CP		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a,b]Means (% weight) within columns with no common superscript differ ($P < 0.05$).
[1]Weeks of age.
[2]Eviscerated.
[3]Pooled standard error of mean.

TABLE 8. Correlation coefficients among weights of major component parts of French guinea broilers fed diets with varying concentrations of CP and ME

Component part	Carcass[1]	Breast	Thigh	Drumstick	Wings	Neck	Abdominal Fat	Heart	Liver	Gizzard
Live weight	0.76**	0.43**	0.66**	0.47**	0.40**	0.29*	0.28*	0.27*	0.29*	0.11
Carcass[1]		0.59**	0.85**	0.60**	0.63**	0.41**	0.28*	0.32*	0.21	–0.06
Breast			0.34*	0.03	0.10	0.14	0.33*	0.11	0.12	–0.08
Thigh				0.65**	0.55**	0.38*	0.18	0.23	0.18	–0.07
Drumstick					0.45*	0.42*	–0.12	0.35*	0.11	0.12
Wings						0.33*	–0.17	0.08	–0.16	–0.09
Neck							–0.11	0.25	0.11	0.04
Abdominal fat								0.05	0.34*	–0.12
Heart									0.24*	0.09
Liver										–0.01

[1]Eviscerated carcass weight.

*$P < 0.05$.

**$P < 0.01$.

fed the 21% CP diets. It was also observed that birds fed 25% CP diets deposited about 10% more abdominal fat than those on a 23 or 21% CP diet. Birds on 25% CP diets consumed more feed and had heavier BW than those fed 23 and 21% CP diets. Correlation coefficients between abdominal fat and BW (Table 8) were positive and significant ($P < 0.05$), which further support this observation. Other related studies using broiler-type chickens (Nahashon et al., 2000) reported a positive and significant correlation between abdominal fat weight and BW in broiler-type chickens. Thus, the higher percentage of abdominal fat in guinea broilers on 25% CP could be attributed to the increased feed consumption of these birds than those fed the 23 or 21% CP diet. This might have resulted in caloric over consumption, the excess of which was deposited as fat. Wang et al. (1991) reported positive correlations ($P < 0.05$) between feed consumption and abdominal fat in broiler sire and dam populations that were greater than 0.7. Abdominal fat weights of birds on 23 and 21% CP diets were not different. Differences in thigh, drumstick, wings, neck, heart, liver, and gizzard weights of French guinea broilers were not significant among dietary CP levels.

Correlation coefficients among weight of major component parts of French guinea broilers are presented in Table 8. Positive and highly significant correlations were noted between live weight and weight of carcass, breast, thigh, drumstick, and wing of French guinea broilers. Correlations between carcass weight and breast, thigh, drumstick, wing, and neck weight and between thigh weight and drumstick and wing weights were also positive and high ($P < 0.01$). It was noted that abdominal fat weight was positively correlated with live, carcass, breast, and liver weights of the guinea broilers. In other studies with broiler sire and dam populations, Wang et al. (1991) also reported positive but small to moderate correlations of body and carcass weight and weight gain. Positive and significant correlations were also observed between live weight and weights of the liver and heart. The liver and heart play key roles in metabolism and translocation of nutrients and as such they will respond to work load as has been observed previously in the cardiac muscle (Morgan et al., 1980) and the liver (Ferrell and Koong, 1986).

Therefore, based on this study, French guinea broilers seem to use more efficiently diets containing 3,100 kcal of ME/kg and 23% CP at hatch to 4 WOA and 3,150 kcal of ME/kg and 21% CP from 5 to 8 WOA. Birds on these dietary treatments exhibited superior BW gain, feed conversion, carcass weight, and breast weight. Significant correlations between BW gain and carcass and breast weights also support this conclusion.

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